AdaptLIL: A Gaze-Adaptive Visualization for Ontology Mapping

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Github

Video Preview

System Design

Start

AdaptLIL processes only the user's eye gaze direction on the screen.

<REC BPOGX="0.01" BPOGY="0.02">
<REC BPOGX="0.02" BPOGY="0.03"/>
<REC .... /> for N number of samples

Eye Tracker

Eye Tracker collects gaze data.

Gazepoint API

Custom implementation of Gazepoint's API to convert XML data to Plain Old Java Objects in real-time.

... for N packets

Mediator design pattern to dictate and orchestrate the components

Gaze Window stores the eye gaze data in 2 second chunks

Gaze Window

RecXml
BPOGX: float
BPOGY: float
BPOGV: bool

Plain Old Java Object

!windowFull
Add Gaze Data

windowFull

Adaptation Mediator

Gaze Window
Task Success or Failure

Python Server

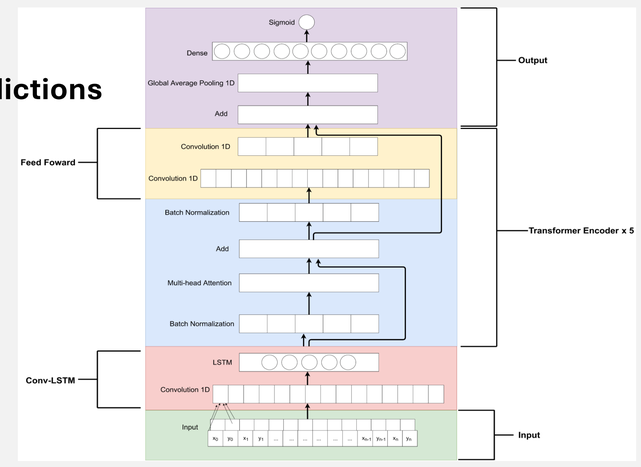
Python server designed to support the fast-paced advancements in the deep learning ecosystem.

... for 5 Predictions

Gaze Window
Task Success or Failure

Convolutional LSTM + Time Series Transformer used to help the model predict task success/failure during long interactions with visualizations

Deep Learning Model



Confidence of Failure	# of Failure Classifications	Additional Conditions	Adaptation Action
High Confidence	5/5 or 4/5	2 minutes after new adaptation type or adaptation does not exist	Select new adaptation
Moderate Confidence	5/5 or 4/5	Adaptation exists	Flip direction of adaptation strength and increase/decrease strength by 25%
Mild Confidence	3/5 or 2/5	Adaptation does not exist	Select new adaptation
Mild Confidence	3/5 or 2/5	Adaptation exists	Increase/decrease adaptation strength by 25%
Low Confidence	1/5 or 0/5	None	Do nothing

Rule-Based Adaptation Selection process make continuous adjustments depending on the current predicted confidence of failure.

```
Message Body: {
    "type": "invoke",
    "name": "adaptation",
    "adaptation": {
        "type": "deemphasis" | "highlighting",
        "state": true | false, //on/off
        "strength": [0-1]
    }
}
```

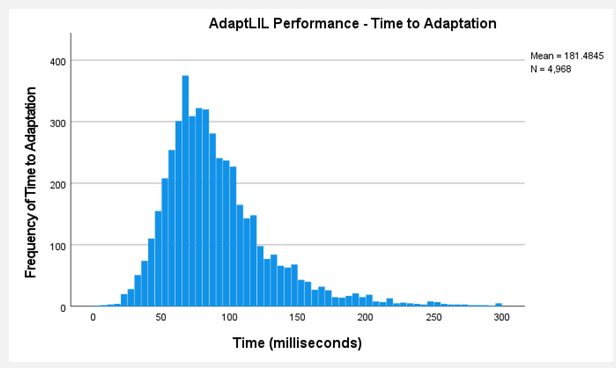
Visualization Frontend

The WebSocket transmits JSON data to enable the receiver to dynamically adjust the visualization.

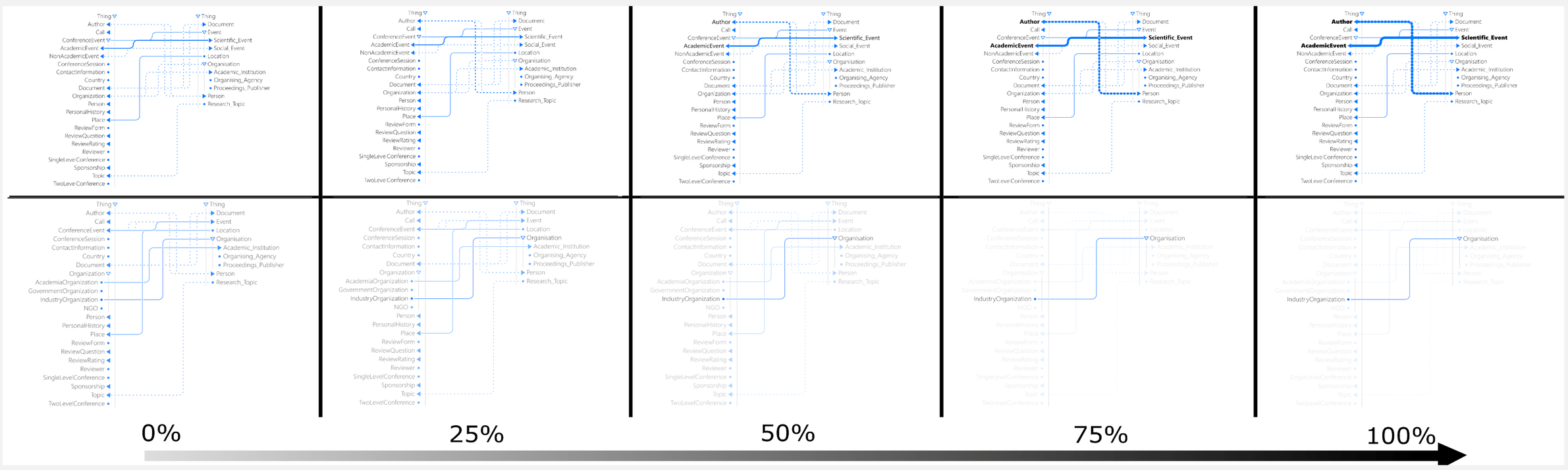
What is AdaptLIL?

- AdaptLIL is a physiology-driven adaptive indented list visualization for ontology mappings.
- AdaptLIL processes user eye gaze data and adjusts graphical overlays to optimize support during task evaluations.
- AdaptLIL monitors the state and strength of adaptations, adjusting visual prominence when it detects a high likelihood of user failure in a task.
- Results show users are 6% more successful in completing tasks with AdaptLIL compared to a non-adaptive visualization when given the same question set ($p < 0.05$).
- AdaptLIL introduces a novel architecture for building adaptive visualizations, extending beyond just ontology mappings.

Performance



Time-to-adaptation - 180ms
Time for one prediction - 36ms



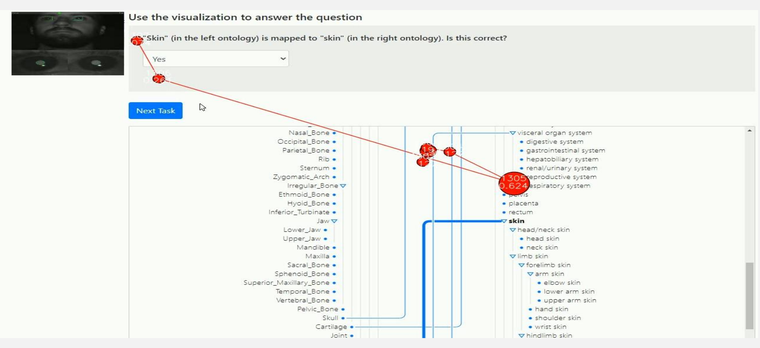
All Adaptation States of the Visualization

Future Research Directions

- Increasing accessibility of AdaptLIL by using Webcam in place of a dedicated eye tracker
- Different adaptation types such as color schemes and backgrounds
- Identifying the best adaptation type to use depending on given ontology mapping task

Acknowledgements

Thank you to Dr. Bo Fu for providing the resources and guidance to turn this system design into reality.



User Study